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First Named Inventor	Michikazu MATSUMOTO et al.
Group Art Unit	2826
Examiner Name	Fazli Erdem
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ENCLOSURES *(check all that apply)*

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SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

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Date	October 17, 2002

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Docket No. 740819-610

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:	)	
Michikazu Matsumoto et al.	)	Group Art Unit: 2826
Serial No. 09/922,804	)	Examiner: Fazli Erdem
Filed: August 7, 2001	)	
For: ELECTRODE STRUCTURE AND METHOD FOR FABRICATING THE SAME	)	Date: October 17, 2002

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REQUEST FOR RECONSIDERATION

Commissioner for Patents
Washington, D.C. 20231

Sir:

In response to the Office Action dated July 17, 2002, reconsideration in view of the following comments is respectfully requested.

Applicants would like to thank Examiner Erdem for the indication that claims 6 and 10 contain allowable subject matter.

The Office Action rejects claims 1 and 3-5 under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 6,218,256 to Agarwal (hereinafter "Agarwal"). This rejection is respectfully traversed.

In general, exemplary embodiments of the present invention relate to an electrode structure including a silicon-containing film containing silicon as the principle constituent. A barrier metal layer is formed on the silicon-containing film and a metal layer with a high melting point is formed on the barrier metal layer.

Conventionally, if a barrier filmed is composed of titanium nitride (TiN), nitrogen in the barrier film reacts with the silicon in a polysilicon film to form a reaction layer composed of silicon nitride (Si) film at the interface, and the interface resistance increases. In an effort to help compensate for this problem, an aspect of the present invention is to lower the interface resistances between the silicon-containing film and the metal film having a high melting point in an electrode structure.

Accordingly, claims 1 and 3 recite, *inter alia*,...the barrier metal layer of the titanium nitride rich in titanium as compared with the stoichiometric ratio is formed between the silicon-containing film and the metal film having a high melting point. Therefore, the amount of nitrogen included in the barrier metal layer is small. Accordingly, since the barrier metal layer includes a small amount of nitrogen that reacts with the silicon of the silicon-containing film through a high temperature annealing process of the electrode structure, a reaction layer of a compound principally including silicon and nitrogen is never formed or, if formed, is merely a small thickness between the barrier metal layer and the silicon-containing film. As a result, even when the electrode structure is subjected to high temperature annealing, the interface resistance between the silicon-containing film and the barrier metal layer can be prevented from increasing and therefore, the interface resistance between the silicon-containing film and the metal film can be prevented from increasing.

In accordance with claims 2 and 7, since the first barrier metal layer of the titanium nitride rich in titanium as compared with the stoichiometric ratio is formed on the silicon-containing film, the amount of nitrogen reacting with the silicon of the silicon-containing film through the high temperature annealing process is small. Therefore, a reaction layer compound principally including silicon and nitrogen is never formed, or, if formed, is merely a small thickness between the first barrier metal layer and the silicon-containing film. Accordingly, even when the electrode structure is subjected to high temperature annealing, the interface resistance between the silicon-containing film and the first barrier metal layer can be prevented from increasing, and therefore the interface resistances between the silicon-containing film and the metal film can be prevented from increasing.

Furthermore, since the first barrier metal layer and the second barrier metal layer, in

which the nitrogen composite is higher then the stoichiometric ratio, are disposed between the silicon-containing film and the metal film, a dopant introduced into the silicon-containing film is prevented from moving by the first barrier metal layer and the second barrier metal layer and therefore, is also so prevented from diffusing into the metal film. Additionally, a silicon layer of the metal that has a high melting point can be avoided from being formed through a reaction between the silicon of the silicon-containing film and the high melting point metal of the metal film.

In contrast, Agarwal teaches an invention that relates to a capacitor for DRAM and its barrier layer. According to Agarwal, a pocket (46) is formed in a substrate (10), and a lower electrode (12) lines the walls of the pocket (46) and is fabricated with HSG poly-silicon that provides a textured surface (48). Then, a dielectric (14) composed of Ta_2O_5 is layered over the textured surface (48) of the lower electrode (12). After forming a barrier metal layer (16), which functions as an undercoat layer of an upper electrode (16) composed of TiN, over the dielectric (14), annealing is performed in an oxygen ambient to form the barrier metal layer (16) in an oxygen saturated state. Thereafter, an upper electrode (18) composed of a metal film with a high melting point is formed on the barrier metal layer (16).

Hence, the dielectric film (Ta_2O_5) and the barrier metal layer (TiN) are disposed between the poly-silicon film and the high melting point metal film. Moreover, the barrier metal layer that is rich in oxygen is formed by oxygen-annealing.

However, and in contrast, according to the structure of the electrode for the present invention, only the barrier metal layer that is rich in Ti and composed of TiN is formed between the silicon containing film and the metal film having the high melting point, and a dielectric film such as that disclosed by Agarwal is not required. Furthermore, the barrier metal layer of the present invention is a TiN layer that is rich in Ti and the TiN layer of Agarwal is a TiN layer that is rich in oxygen.

Therefore, Applicants respectfully submit that the structure and the effect of the electrode of the present invention is completely different from that of the capacitor in Agarwal.

Furthermore, the film composition of the barrier metal layer of the present invention is also different than that of Agarwal. Accordingly, Applicants respectfully submit that since Agarwal fails to teach, suggests or disclose each and every feature as recited in the claims, Agarwal fails to anticipate claims 1 and 3-5. Withdrawal of the rejection of claims 1 and 3-5 under 35 U.S.C. §102(b) is respectfully requested.

The Office Action rejects claims 2 and 7-9 under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,973,408 to Nagasaka et al. (hereinafter "Nagasaka") in view of U.S. Patent No. 5,561,326 to Ito et al. (hereinafter "Ito"). This rejection is respectfully traversed.

Nagasaka is directed toward a barrier layer for a contact electrode. In particular, a second TiN film (261B) (number Ti atom arrange from 50%-59%) is formed on a contact area (42) of a Si device, a first TiN film (261A) that is rich in Ti and composed of TiN (number Ti atom range form 62%-75%) is formed on the second TiN film (261B), and electrode wiring (151) is formed on the first TiN film (261A).

Therefore, the barrier metal layer (261) is a two-layer structure. The upper-first barrier metal layer that is connected to the electrode wiring is a TiN layer rich in Ti, and the lower second barrier metal layer that is connected to the Si is a TiN layer having almost the same stoichiometric ratio.

However, according to the two-layer structure of the barrier metal layer that is claimed, the lower first barrier metal layer connected to the silicon-containing film is a TiN layer rich in Ti, and the upper second barrier metal layer connected to the metal film having a high melting point has a nitrogen composition higher than the stoichiometric ratio. Therefore, the barrier metal layer of the present invention is different from that disclosed in Nagasaka.

Further in contrast, Ito is directed toward a barrier layer for contact wiring. According to Ito, a Ti layer (185) is formed within a contact hole (183) provided in Si substrate (180). A second TiN_x layer (187) (X = 0-1), which nitrogen content progressively increases with respect to the Ti content is formed on the Ti layer (185). Thereafter, a first TiN layer (186) is formed on

a second TiN_x (187), and wiring conduct layer (182) is formed on the first TiN layer (186).

Therefore, the barrier metal layer (184) is a three-layered structure, and the second TiN_x (the middle layer) is a TiN layer (for example Ti_2O) rich in Ti. However, Ito at least fails to teach, suggest or disclose a TiN layer having a high concentration of nitride as asserted by the Office.

Therefore, the film composition of the barrier metal layer of the present invention and that of Ito are completely different, and the combination of Nagasaka and Ito fail to teach, suggest or disclose each and every feature of the claimed invention. Therefore, the cited references, either alone or in combination fail to render obvious claims 2 and 7-9. Withdrawal of the rejection claims 2 and 7-9 under 35 U.S.C. §103(a) are respectfully requested.

Applicants respectfully submit that the application is in condition for allowance. Favorable reconsideration and prompt allowance are respectfully requested.

Should the Examiner believe anything further is desirable in order to place the application in even better condition for allowance, the Examiner encouraged to contact Applicants' undersigned representative at the telephone number below.

Respectfully submitted,

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